DOWN TO EARTH

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A REVIEW OF AGRICULTURAL CHEMICAL PROGRESS

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NEW SEED FUNGICIDE

shows real promise

THE PROBLEM of plant diseases has been a serious one since the begining of civilization, since man began to cultivate crops for his benefit alone. For centuries speculation as to the cause of plant diseases was rife and on the fantastic side in view of our present day knowledge. It was only after the disease epidemics that destroyed European crops one hundred years ago that the true picture of plant disease as caused by tiny, microscopic plants known as molds or fungi was revealed by the German mycologist, Anton DeBary.

With a better understanding of the nature of plant disease there began an intensive search for chemicals to control the disease-producing micro-organisms. The search for control was directed not only at those micro-organisms that produced visible leaf spots, blights and wilts of foliage, but also those that attacked the germinating seeds in the ground.

Prévost's discovery in 1807 that germinating smut spores were killed when infinitesmal amounts of copper were added to the surrounding moisture provided the stepping stone that led to the use of copper sulphate, with and without lime, for the treatment of cereal grain seed prior to sowing. Formaldehyde and, eventually, copper carbonate dust were introduced as seed treatments to combat the several types of grain smuts.

But new diseases were being discovered against which these materials were not always effective. In the soil there was a complex of several fungi that attacked various seeds in the cool, moist spring, killing many before the young shoots penetrated to the surface, resulting in poor stands and reduced yields. Riehm, one-hundred years after Prévost, and following a lead taken from medical science, established the use of mercurials for the treatment of a greater variety of seeds than was previously possible.

The search goes on, apparently a never ending one, to find a universal cure-all. The scientifically curious continue to press forward, always looking for chemicals less specific in their action, more nearly perfect in disease control, but which remain harmless to the seed and to man. It was with the advent of World War II and the reduction in availability of many standard fungicides that a new incentive was provided in the search for new materials that might replace or substitute for chemicals critically needed in the war effort. "Spergon" appeared, marketed by the United States Rubber Company, as the first true organic chemical seed protectant, which contained tetrachloro-p-benzoquinone as the active ingredient. More recently "Phygon", a dichloro-naphthoquinone, has appeared as a companion product. DuPont Semesan Company supplemented its line of mercurials with "Arasan," a vegetable seed dust containing tetramethyl thiuram disulphide. Others have appeared and disappeared, unable to meet the high requirements of a good seed fungicide. Some are still in the experimental stage, going through the final acid tests that all must pass before they are acceptable as contributions toward man's better living.

This fall The Dow Chemical Company will offer a new seed protectant containing zinc trichlorophenate and known as Dow 9B. Being a phenolic material, it is a logical companion product to the already well-known line of Dowicides now used as industrial germicides. Of the numerous chemicals tested at the Dow Biochemical Research Laboratories during the past years, sodium trichlorophenate was one of a few that showed real promise as a fungicidal dust for cotton seed treatment. Additional research with a number of salts of the parent phenol led to the eventual selection of the zinc salt of trichlorophenol. The performance of this seed fungicide has been gratifying in the many tests that have been conducted during the past three years.

To be a good seed fungicide a chemical should possess

DOWN TO EARTH • A Review of Agricultural Chemical Progress, Published by THE DOW CHEMICAL COMPANY, Midland, Michigan, manufacturers of agricultural chemicals. Thirteen thousand copies distributed to those engaged in agricultural research in the United States and Canada. • Eugene Perrin, Editor.

IN THIS ISSUE • *New seed fungicide shows real promise.* • *Retarding Sprout growth of potatoes and root crops in storage.* • *Propylene dichloride emulsion controls the peach borer* • *Dowspray 202 for setting tomatoes* • *Hexachlorocyclohexane . . . a new triple-action insecticide.*

ON THE COVER • *A successful seed fungicide increased the yield of the wheat in the background. A different compound was used for the plots where the research worker is standing; results are fair. Plots in the foreground are untreated. Plots are at Midland, Michigan.*

At Dow's Midland Agricultural Chemical Laboratory seeds are dusted with fungicides in this rotary drum.

The soil in these pots was infested with damping off diseases. Ten seeds were planted in each pot. Pots in background show excellent yield from seed fungicide treatment. The plants are peas.

the basic ability to disinfect the outer seed surface, freeing it of all disease spores borne upon it, thereby giving rise to the term "seed disinfectant." Likewise, the chemical should act as a "seed protectant" to form a thin barrier around the seed, capable of killing or repelling, once the seed is planted, the attacks of micro-organisms present in the soil.

Dow Seed Protectant 9B is one of the few seed fungicides that possess both these qualities. On cotton seed it has materially increased the rate of emergence of seedlings, not only by protecting them from the various "damping-off" soil-inhabiting fungi, but also by ridding the seed of anthracnose spores (*Glomerella cingulata* (E. A. Southworth) Edg.) carried upon its fuzzy surface and which cause serious losses in the cotton areas east of the Mississippi.

In Figure 1 are shown the representative results of tests on fuzzy Mexican cotton seed, carrying natural inoculum of *G. cingulata.* This seed was treated with several concentrations of zinc trichlorophenate applied at one-half normal dosage, normal dosage, twice, and four times normal dosage. The total seedling emergence was quite uniform except in cases in which excessive concentrations and dosages affected the seed germinability. Records of clean seedlings indicated that disease control increased with the dosage up to three ounces per bushel, using 50% zinc trichlorophenate. Higher concentrations and dosages did not increase disease control sufficiently to justify the results. Untreated seed was almost completely infected.

Figure 2 shows the results of similar tests on reginned Mexican cotton seed, in which more low concentrations of zinc trichlorophenate were applied at one and two ounces per bushel of seed. Total emergence from treated seed again was quite uniform and slightly greater than

Fig. 1

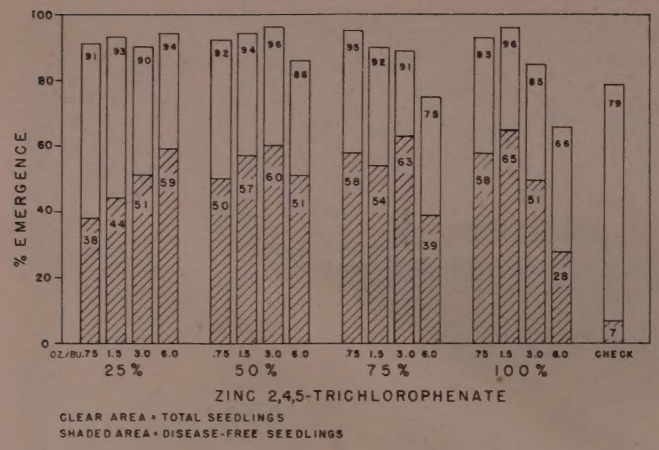
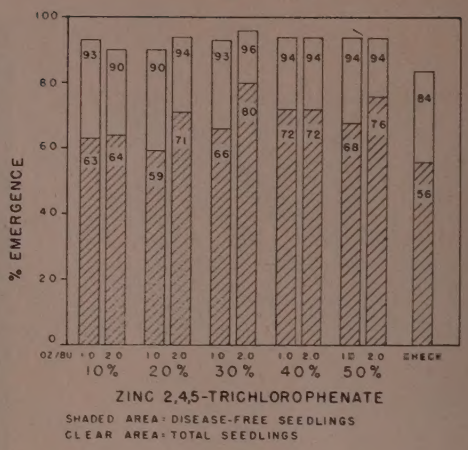


Fig. 2



from untreated seed. Disease-free seedlings were more numerous in these tests because of less inoculum on the reginned seed. However, the results serve to illustrate the useful range of zinc trichlorophenate as being between 30% and 50%. On the basis of many such tests the present composition of Dow Seed Protectant 9B, contain—50% active chemical, was selected.

On many varieties of vegetable seeds Dow 9B has proven satisfactory in increasing seedling emergence in heavily infested soils. Eventually the performance of Dow 9B will be established for all economic seeds, for despite its evident value on many crops it is not effective on all, but like the DDT insecticide and other agricultural chemicals, it exhibits a certain degree of specificity.

Methods of application and dosages are no different from standard procedures now used. The dust is applied to seeds in a closed container or in seed-treating equipment and tumbled until uniform coverage is obtained. The seeds may be planted immediately after treatment or they may be stored without reducing the effectiveness of the fungicide or the viability of the seed. In a storage test of nine-months duration, in which treated seeds of several types were held in a commercial seed warehouse, the emergence of some seeds was definitely increased during the storage period as compared with results of freshly-treated seed.

Zinc trichlorophenate is a white dust, having a phenolic odor, easily detected but not obnoxious unless it is inhaled in a fairly heavy concentration. In such cases it acts as a nasal irritant and may result in sneezing. Its action is temporary and local with no lasting effect. Care should be exercised in handling this material, for although Dow 9B is relatively insoluble, like most chemicals, it should not be allowed to remain in continuous contact with the skin.

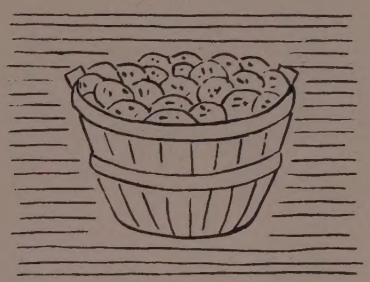
The center row in this plot shows what happens to untreated cotton seed. Picture courtesy Prof. S. G. Lehman, North Carolina State Agricultural College)

Many of the larger growers and more progressive farmers realize the value of seed treatment to combat disease. It also brings them savings in amount of seed required and labor of thinning excess plants. In addition there is a saving in the cost of both seed and labor required in re-seeding areas that failed because of disease developing in the first planting. Seed treatment, although growing in favor, must be taught as an educational agricultural program. Farmers must be urged to look upon it as a form of crop insurance. Like lightning, no one can predict when the elements will strike next to provide weather optimum for the numerous soil fungi to develop and attack newly planted seeds.

Retarding Sprout Growth

OF POTATOES AND ROOT CROPS

In Storage



By ORA SMITH
DEPARTMENT OF VEGETABLE CROPS,
CORNELL UNIVERSITY

SEVERAL MILLIONS of bushels of potatoes are lost every year as a direct result of sprout growth during storage. Shrinkage by loss of water through the sprouts with resultant shrivelling is very common in many storage houses. If storage house temperatures could be maintained under 40°F. very little, if any, sprout growth would occur. However, in many cases, it is impossible to maintain such temperatures throughout the storage season. As a result, excessive sprout growth and weight losses occur.

Results of storage experiments in connection with culinary quality of potatoes show that best cooking quality potatoes result when they are stored above 40°F. From the point of view of potato dehydrators and potato chip manufacturers, storage temperatures are extremely important. Reducing sugars accumulate in excessive amounts in potatoes stored at 40°F. or lower. Excessive reducing sugar content of potatoes is responsible for the undesirable brown color of potato chips and also causes very objectionable discolorations in dehydrated potatoes. Hence, it is extremely important to have available to growers, distributors, potato dehydrators and potato chip manufacturers a material which will permit higher storage temperatures but which will prevent or greatly retard growth of sprouts and subsequent weight losses of the potatoes. Such a material we now have in the form of the methyl ester of alpha naphthalene acetic acid.

This chemical may be applied in any of several forms such as (1) shredded or confettied paper which has been soaked in or sprayed with the chemical, (2) inert dusts such as talc, walnut shell flour, Pyrax, etc. with which the chemical has been thoroughly mixed, (3) atomized through a paint spray gun onto the potatoes as they are placed in the bin and (4) applied to the potatoes as they are placed in the bin as an Aerosol with methyl chloride.

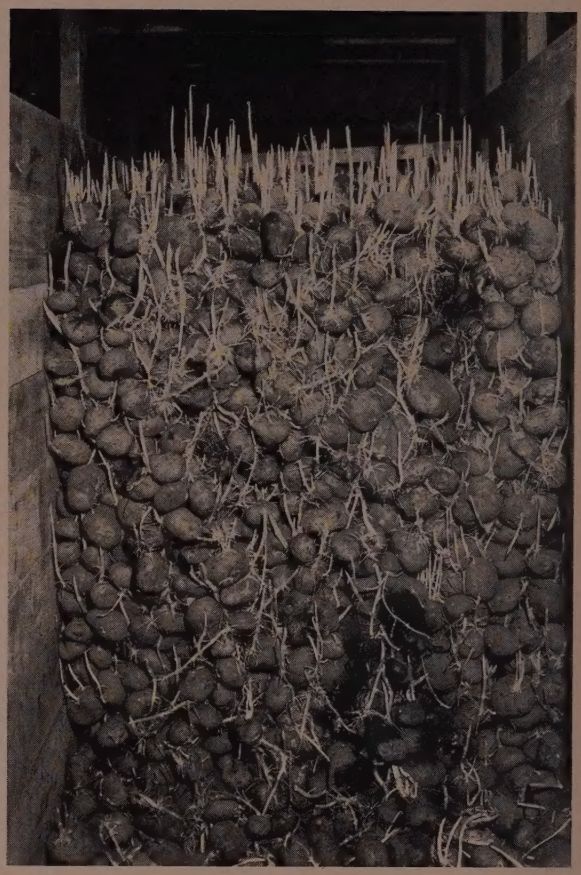
A small amount of the treated paper or dust should be applied with every few bushels placed in the bin so that the chemical is distributed uniformly throughout the bin. The amount of paper or dust to use will depend on the concentration of the methyl ester in the paper or dust. For best results from 0.9 to 1.0 gram of methyl ester of alpha naphthalene acetic acid should be applied to each bushel of potatoes. When any of these methods of application are used at the proper strength, potatoes may be kept dormant or with only very short sprouts for four or five months at temperatures of 50 to 55°F. or at higher temperatures for shorter periods.

No undesirable effects on table stock potatoes have been noticeable as a result of these treatments. It is recommended that potatoes that are to be used for seed purposes *not be treated* with this chemical until more experimental evidence is obtained as to the rate and type of growth that will occur in the field the following season.

Experiments for the retardation of sprout growth in potatoes were continued during the 1945-46 season in the storages of three potato chip manufacturers, two large scale potato growers and in the potato storage of the Department of Vegetable Crops, Cornell University. The results of four month's storage in bushel crates at high temperatures such as potato chip manufacturers might use are presented in table 1. The treatment of methyl ester applied from an Aerosol with methyl chloride lost least weight although sprout growth was a little more extensive than on the treatment where methyl ester was atomized from a paint spray gun. Both had much less sprout growth than the untreated lots and did not have as high shrinkage loss as the untreated.

In table 2 the results are presented of the Sebago variety stored in bulk for 6½ months in common storage varying in temperature from 36° to 50°F. The potatoes treated with the methyl ester impregnated paper had the least amount of sprout growth and the least loss in weight although it was only slightly lower in each case than those treated with the impregnated brown dust. The lots treated with methyl ester atomized from a paint spray gun as they were placed into storage were next lowest in sprout growth and total weight lost. All were very much better than the untreated lots. The shredded paper was impregnated with the methyl ester in such concentration that six pounds of the paper to each 100 bushels of potatoes supplied methyl ester at the

This picture was taken on April 30, 1945, of potatoes stored in October, 1944. They were stored in paper impregnated with methyl ester of naphthalene acetic acid. White strips in this picture are paper . . . not sprouts. (Cornell University Photo)



Here's what sprouts looked like to the camera. This bin was untreated. (Cornell University Photo)

rate of 1 gram per bushel of potatoes. For several years this form of the material has given excellent results.

Each pound of brown dust was impregnated with 3.6 grams of methyl ester and applied uniformly to four bushels of potatoes. This supplied 0.9 gram of methyl ester to each bushel of potatoes. This material has given very good results during the past three years. Recent tests indicate that this concentration could be increased with satisfactory results so that each pound of dust would contain 10 grams of methyl ester and could be applied to 10 or 11 bushels of potatoes.

When applied through the paint spray gun the methyl ester of naphthalene acetic acid was first diluted with methyl alcohol, usually 1 to 1. The paint spray gun is mounted on the bin loader atomizing the mixture back onto the potatoes as they fall from the separating chain onto the belt. This may be enclosed with canvas or other material to prevent direct escape of the fumes. The spray nozzle is so adjusted with rate of unloading the potatoes so that one gram of methyl ester is applied to each bushel of potatoes. This method of application is very convenient and rapid and has resulted in satisfactory retardation of sprout growth.

The methyl ester of naphthalene acetic acid was applied by Aerosol with the proportion of one part methyl ester to nine parts of methyl chloride. The Aerosol is mounted on the bin loader as previously described for the paint spray gun and adjusted so that one gram of methyl ester is applied to each bushel of potatoes. In cooperation with the G.L.F. Exchange last year, one grower on Long Island treated 30,000 bushels of potatoes with the Aerosol method of methyl ester with very marked success. Sprout growth was greatly retarded and the grower received a premium price for the treated potatoes over those not treated.

For small lots of potatoes up to those of 1000 bushels we would recommend the paper or dust form of application. They are both highly functional in retarding sprout growth with no deleterious results. For larger scale treatment the handling of paper or dust becomes a problem and we would recommend application of the methyl ester through a paint spray gun. Dilutions may be made with methyl alcohol or possibly some other safe material which is miscible with the methyl ester. This form of application is easy, rapid and has resulted in very good control of sprouting.

In other experiments during the past season quantities of potatoes were stored but no loss in weight data were taken. Several thousand bushels of potatoes were treated and placed

Left: Treated carrots; Right: untreated. (Cornell University Photo)

Left: Turnips treated with methyl ester of alpha naphthalene acetic acid; right: untreated. (Cornell University Photo)

Left: Treated beets; Right: untreated. (Cornell University Photo)

TABLE 1. The effect of several methods of applying methyl ester of naphthalene acetic acid to potatoes on sprout growth and shrinkage in storage. Variety—Katahdin. Four months at 60-65°F.

Treatment	*(*Total Weight)*		*Wt. of sprouts †(grams)*	*Wt. of potatoes minus sprouts April 22†*	*Total shrinkage %*
	Dec. 18	*April 22*			
	(lbs.)				
Untreated	60	55.15	1517	51.78	13.70
Methyl ester applied with paint spray gun	60	54.58	439	53.61	10.65
Methyl ester in methyl chloride applied from Aerosol	60	55.88	759	54.18	9.70

* Average of 15 lots of 60 lbs. each weighed separately.

† Average of 6 lots weighed separately.

in potato growers' or potato chip manufacturers' storages. Observations were later made on relative amounts of sprout growth, rot, etc. in each treatment. Treatment with any form of methyl ester of alpha naphthalene acetic acid consistently resulted in less sprout growth than those not treated and in no case was the amount of rot increased by any of the treatments. We have successfully treated in large quantities potatoes of the following varieties: Sebago, Katahdin, Sequoia, Earlaine No. 2, Smooth Rural and Russet Rural.

This picture shows some results of tests at Midland, Michigan by Dow research workers. Specimens from Bin 7 show a check on Russets. Bin 10 is a dust treatment of methyl ester of naphthalene acetic acid on Russets.

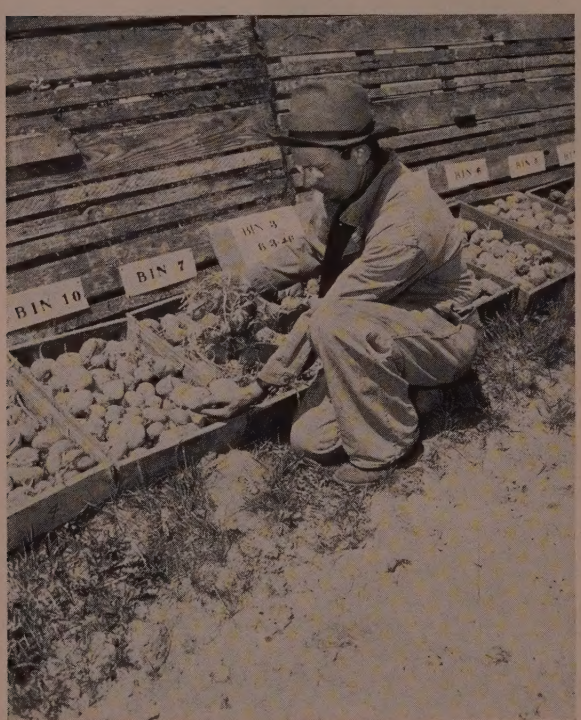


TABLE 2. The effect of various methods of applying methyl ester of naphthalene acetic acid to potatoes on sprout growth and shrinkage in storage. Variety—Sebago. October 25, 1945 to May 10, 1946.

Method of treating	*Weight of sprouts per 10 bushel lot*	*Total loss in weight per 10 bushel lot*	*Total shrinkage (percent)*
	lbs. ozs.	*lbs. ozs.*	
Not treated	6 - 14	73 - 14	12.30
Methyl ester atomized with paint spray gun	5 - 2	48 - 2	8.02
Brown dust impregnated with methyl ester	3 - 10	39 - 10	6.53
Shredded paper impregnated with methyl ester	3 - 7	35 - 0	5.83

Although it is not yet recommended as a practice to commercial growers, results of experiments in the field in 1945 show that spraying the methyl ester on the foliage during the growing season had a retarding effect on subsequent sprout growth in storage.

All who have stored any of the root crops such as beets, carrots, turnips and rutabagas know that two of the most important storage difficulties with these crops are sprouting and shrivelling. The higher the humidity of the storage air, the lesser the amount of shrivelling. However, if at high humidities the temperature also is much above 40°, the root and top growth will be excessive often resulting in decay of the stored product.

By a very simple procedure it is now possible to prevent or greatly retard root and top growth of these root crops in storage. The same chemical, namely, methyl ester of alpha naphthalene acetic acid, which prevents or retards sprout growth in potatoes also will retard root and top growth in the root crops. This results in less decay and better keeping qualities.

Probably the best method of application of this chemical is to spread a small amount of it impregnated in shredded or confettied paper or in an inert dust in the container, bin, pile or pit where they are stored. The paper or dust containing the chemical should be distributed fairly evenly throughout the bin or pit of root crops at the same rate that is recommended for potatoes. Other methods of application are now being studied. Large scale storage of turnips and rutabagas with the confetti paper form of methyl ester has been very successful in Long Island.

The use of this chemical should be of value especially for the home storage of root crops as well as to the market gardener and truck grower who store root crops in outdoor pits and cellars and also to the canners and dehydrators who wish to store these crops in large quantities for a period of three to five months or longer before processing.

EDITOR'S NOTE: *This fall The Dow Chemical Company will offer methyl ester of naphthalene acetic acid for limited sale as DOW SPROUT INHIBITOR. Confetti paper, dust and liquid concentrate formulations will be available.*

PROPYLENE DICHLORIDE EMULSION

Controls the Peach Borer

Recent experiments by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine at Fort Valley, Georgia, show Propylene Dichloride Emulsion to be an economical and effective weapon in controlling the peach trees' most devastating enemy.

WHEN MASSES OF GUM exude from the base of the trunk of a peach tree, the grower knows he's in for real trouble from an important enemy . . . the peach borer. This devastating pest eats out extensive areas in the bark of peach trees and leaves a trail of gum and frass often destroying enough living tissue to result in the death of the tree. The peach borer is found in all sections of the United States where the peach is grown and in much of Canada and attacks peach, cherry, plum, prune, apricot, and some shrubs.

The insect, if no control measures are undertaken, is almost certain to kill trees attacked within a few seasons. Control measures today being practiced include paradichlorobenezene and ethylene dichloride. Paradichlorobenzene is used in most orchards. It is applied by placing a small amount of crystals of the chemical on the soil surface around the trunk of the tree during the fall. The crystals in warm weather volatilize into heavy gas which penetrates the barrows under the bark. In recent years many growers have

favored ethylene dichloride applied in the form of an emulsion which is poured on the soil adjacent to the tree. Its primary advantage over paradichlorobenzene is that it can be applied later in the season when temperatures are lower.

New Control Measure

Experiments conducted during the last five years under the direction of Oliver I. Snapp of the United States Department of Agriculture at Fort Valley, Georgia, show that propylene dichloride emulsion has several distinct advantages over either of the two compounds commonly used today. Snapp reports[1] "On various dry and wet soils it has given excellent control of this insect without tree injury when used at one-half the recommended strength of ethylene dichloride, and as these materials cost approximately the same per pound, the propylene dichloride treatment is the cheaper. Propylene dichloride emulsion, like the emulsion of ethylene dichloride, is effective at low soil temperatures and can therefore be used late in the fall and early in the spring, when it is too cold to use paradichlorobenzene effectively. It is safer around young trees, easier to apply, and more effective than paradichlorobenzene. Furthermore, the propylene dichloride treatment requires a minimum of preparation of the soil before application and no attention subsequent to mounding after treatment."

Propylene dichloride resembles in its properties the closely related ethylene dichloride. Like the latter, it is a flammable, clear, colorless liquid. Its boiling point is 95.4°C. and it freezes at a negative 70° C. The chemical is fairly stable in the presence of water; however, its solubility in water is only 0.27 gram per 100 grams of water at 20° C. It is safe to handle unless it is breathed in high concentrations over an extensive period.

Preparation and Application

Snapp's paper[1] discusses the preparation of the propylene dichloride emulsion and its application as follows:

"To avoid cencentration of the vapor and any prolonged breathing of it, the emulsion should be prepared out of doors or in a well-ventilated room. It is desirable that the air temperature be between 50° and 80° F. Since the compound boils at temperatures below the boiling point of water, heat should not be employed in making the emulsion, and the liquid should be kept away from fire and open-flame lights. Propylene dichloride is somewhat more difficult to emulsify than ethylene dichloride; however, a suitable stock emulsion can be prepared by stirring 8 parts by volume of the compound into 1 part by volume of a good grade of potash fish-oil soap—that is, one without an excess of caustic potash and containing approximately 30 per cent of solid material and 70 per cent of water. To make the emulsion, place the potash fish-oil soap in a container and add the propylene dichloride slowly at intervals, stirring constantly. When the propylene dichloride is thoroughly emulsified with the soap, add water slowly with constant stirring until the emulsion measures 2 parts for each part of propylene dichloride used. The stock emulsion should be diluted with water before use, the amount of dilution depending upon the age of the tree and the dosage required (table 1).

"If the stock emulsion breaks down after preparation, which will be indicated by the presence of a curdled mass, or a layer of clear propylene dichloride on the bottom of the container, and if it cannot be readily remixed by moderate agitation, the material must be re-emulsified. This is done by pumping the mixture from one container to another and back into the same container, or by starting over again with a small quantity of potash fish-oil soap to which small quantities of the broken-down emulsion are added slowly at intervals with constant stirring.

TABLE 1—Dilution of stock emulsion, strength of diluted emulsion, and quantity recommended for trees of different ages.

Age of trees (years)	*Quantity to make 10 gallons of diluted emulsion*		*Strength of diluted emulsion*	*Diluted emulsion for each tree*
	Water	*50-percent emulsion*		
	Gallons	*Gallons*	*Percent*	*Pint*
4+	8	2	10	½
3	8½	1½	7.5	½
2	8½	1½	7.5	¼
1	9	1	5	⅛

+ and older

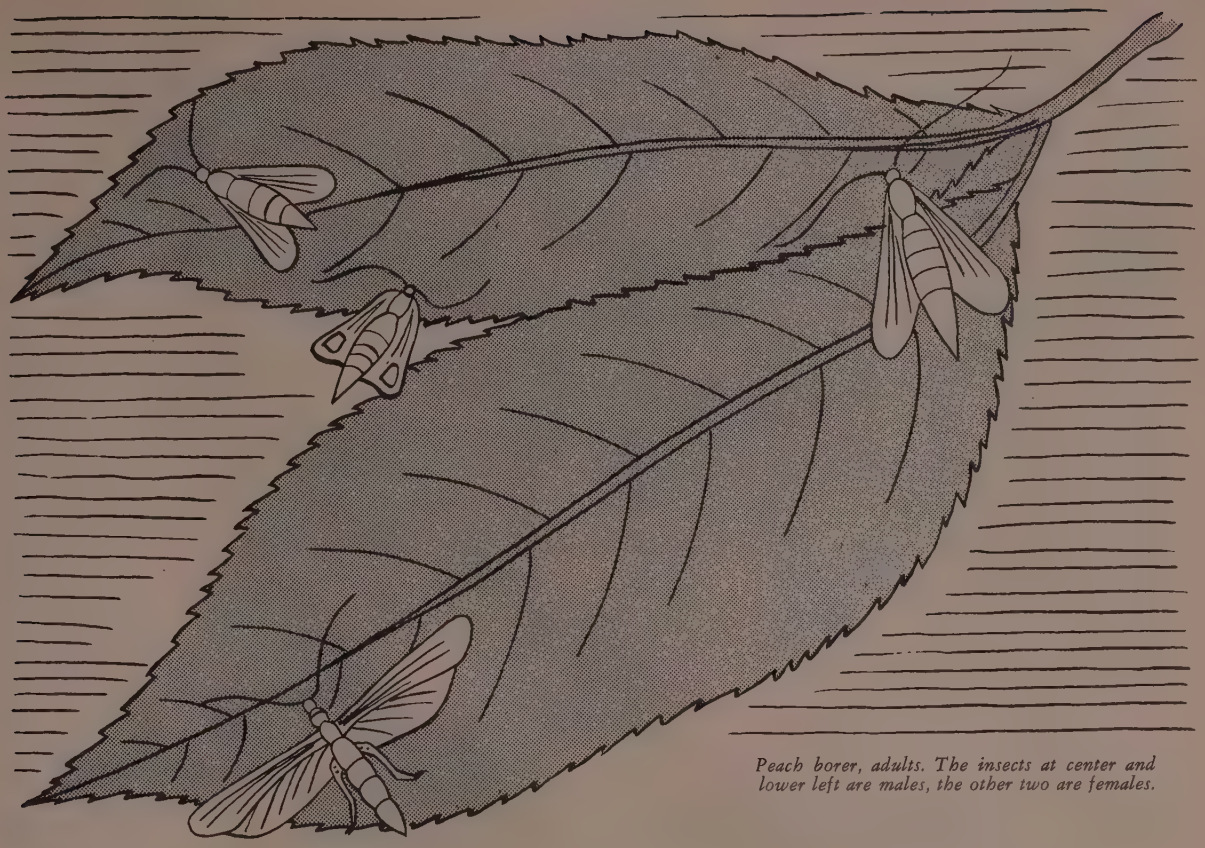
Dilution and Dosage

"Table 1 gives the quantity of water to be added to the 50-percent stock emulsion of propylene dichloride to get 10 gallons of diluted emulsion of the different strengths and dosages found by experiment to be most satisfactory for use around peach trees of various ages.

When and How to Apply the Emulsion

"Propylene dichloride emulsion can be applied for the control of the peachtree borer any time during the fall or spring. Best results will probably be obtained in the fall soon after the close of the egg-laying period of the moths, when most of the borers are small. The material should not be applied to water-logged, heavy soil late in the fall, since it is more likely to cause injury under these conditions.

[1] "Controlling the Peachtree Borer With Propylene Dichloride Emulsion," Oliver I. Snapp, Division of Fruit Insect Investigations, United States Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine, December, 1945, E-676.

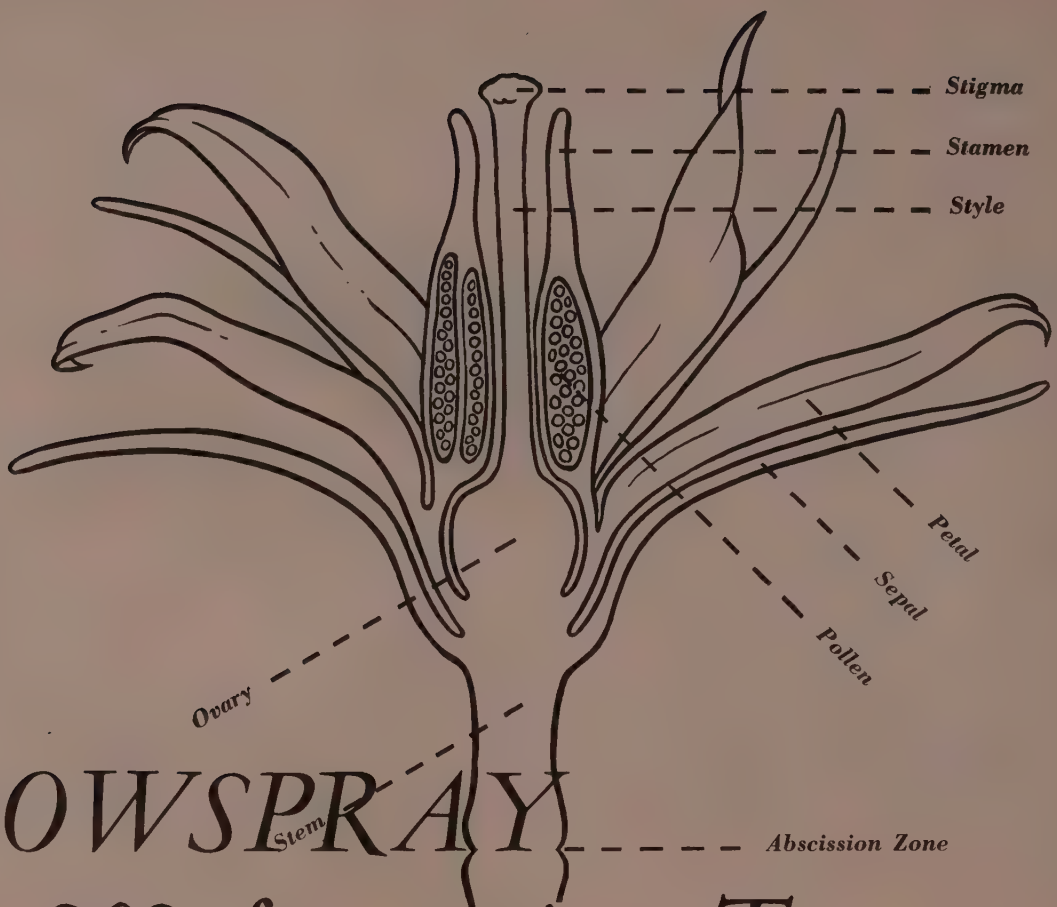


Peach borer, adults. The insects at center and lower left are males, the other two are females.

"No preparation of the soil before treatment is necessary on loose, level ground, except to raise the soil level wherever there are signs of borers in the tree above the normal ground line. In some cases, however, cupping the soil slightly toward the tree trunk or breaking the crust of hard soil to prevent the liquid from running off, or loosening the soil around the trees sufficiently to permit the liquid to be readily absorbed will give better results. Any cracks in the ground around or extending out from the tree trunk should be filled with soil before the treatment is applied, in order that undue concentration of the material on any part of the root system, which might result in injury, may be avoided.

"The material is applied by pouring it on the soil around the base of the tree in such a way that the soil will absorb and hold it around the tree at the ground line. It should not be poured on or allowed to run against the trunk. A tin household measuring cup holding one-half pint, with marks for one-eighth and one-fourth pint, will be found useful for applying the emulsion. It is essential that a uniform mixture be obtained, both in the stock emulsion and in the fully diluted spray. The stock emulsion should be thoroughly stirred before any of it is taken from the container for dilution, and the diluted emulsion should likewise be agitated before each dose is withdrawn for use around the tree. Each bucket of diluted emulsion should be provided with a paddle for agitation. The operator should examine the emulsions at frequent intervals to be certain that they have not broken down, permitting the propylene dichloride to form a separate layer at the bottom of the container. Broken-down emulsions should not be applied, as they are less effective against the borer and the portion consisting chiefly of propylene dichloride may cause serious injury to the tree.

"After the emulsion has been applied, sufficient soil should be placed on it to reduce surface evaporation of the chemical. After this the treatment needs no further attention."



DOWSPRAY 202 for setting Tomatoes

GROWERS OF GREENHOUSE TOMATOES are finding it profitable to use plant growth substances as an aid in producing more fruit during the winter months. Tomatoes grown under glass often do not set fruit well during the winter months and many plants do not yield profitably (See November issue "Down to Earth.") Dr. F. S. Howlett, Ohio State University; Drs. P. W. Zimmerman and A. E. Hitchcock, Boyce Thompson Institute; Drs. Robert and Struckmeyer, University of Wisconsin, and Drs. Murneek and Wittwer, University of Missouri; have shown that certain of the synthetic plant growth substances when sprayed on tomato blossoms will cause the flowers to develop into fruit, even in the total absence of viable pollen. The chemicals most effective in stimulating flowers to form fruit are:

1. Indole acetic acid.
2. Indole butyric acid.
3. Beta-naphthoxy acetic acid
4. Halophenoxy acids.

In the absence of any pollinization these chemicals, properly applied, will stimulate tomato flowers to form fruits that are normal in size but seedless. Usually however, flowers will be at least partially pollinated and most treated fruits will have some seeds. In the event seedless fruit is desired the flowers should be emasculated by clipping the style at the time of treatment and before pollination occurs.

Dowspray 202

Dowspray 202 is a convenient, water soluble concentrate of a mixture of plant growth substances designed especially for treating tomato blossoms to insure setting of fruit. It is a formula that has been developed to give the best possible set with a minimum of hollow fruit and green pulp.

How to Use

Dilute 1 fluid ounce of Dowspray 202 with soft water to make a quart of spray. This spray is applied only on the flowers and may be conveniently handled in a small atomizer such as the Atlas Atomizer No. 82 manufactured by the DeVilbiss Company.

Best results are obtained by treating the flowers in full bloom, buds treated just before opening often do not set

quite as satisfactorily. It is not necessary to treat a blossom more than once. By directing a small amount of the spray towards the *base* of the stamens, adequate coverage is obtained.

The stamens are usually exposed for approximately 3 to 4 days and "full bloom" is ended when the petals close around the stamens. Occasionally, flowers that are past full bloom can be treated successfully if they are still well attached to the stalk. It is suggested that 4 days after a treatment the plants be examined and all open flowers sprayed. Most growers have found it advisable to continue their normal practice of hand pollinating in addition to the chemical treatment.

Recent tests show that Dowspray 202 may have some merit in increasing the set of tomatoes in outdoor plots. More data is needed before recommendations can be made.

(*Pictures courtesy of the W. Atlee Burpee Co.*)

HEXACHLOROCYCLOHEXANE...

a new triple-action INSECTICIDE

War-Born Compound

WORLD WAR II lead to the discovery of DDT . . . and many other important compounds, among them a new insecticide now exciting much interest because of its three-way mode of action. The compound is known as Gammexane and 666 in Britain and as benzene hexachloride and hexachlorocyclohexane in this country. On many pests it is lethal as a stomach poison, a contact agent, or as a fumigant.

Industrial chemists for over a decade have sought to find a synthetic organic substitute to replace such important inorganic insecticides as calcium and lead arsenate and such plant alkaloids as pyrethrum and rotenone. Hexachlorocyclohexane, a discovery of the last war like DDT, apparently holds much promise. In early tests this compound proved highly toxic to aphids, most cotton insects, locust and grasshoppers, ants, and many common animal pests. Like DDT, it can be prepared into such insecticidal compounds as wettable powders, emulsions, oil solutions, and aerosols. In tests so far, it has not proven dangerous to man or animals. The compound has excellent chemical stability and stands exposure to light, hot water, and concentrated nitric acid. Like DDT, however, it is incompatible with lime.

The Gamma Isomer

It is reported that Michael Faraday made hexachlorocyclohexane over a century ago, but it was not until 1943 in England that the chemical's insecticidal value was discovered. In 1942 J. C. Suart of the Imperial Chemical Industries Limited, prepared samples of the alpha and beta isomers of 666. Subsequent tests showed only normal toxicity to weevils by these isomers. Early in 1943, however, Mr. F. J. Thomas of the same firm successfully isolated the gamma isomer and it was found to be more toxic to weevils than any substance that Thomas had ever tested. It was then established that the action of the compound was due almost entirely to the presence of the gamma isomer.

Efficiency and Scope

As A Cotton Insecticide

In 1946 at Waco, Texas, laboratory and cage tests by the U.S.D.A. Bureau of Entomology and Plant Quarantine showed that benzene hexachloride dust gave excellent control of several of the more important cotton insects. "Control of the boll weevil and the cotton leafworm was better than with calcium arsenate. Control of the cotton flea hopper, the tarnished plant bug, and the southern green stinkbug was equal to or better than control obtained with DDT. Better control of the cotton aphid, Aphis gossypii Glov., was obtained than with nicotine dusts. Poor control was obtained with the bollworm. DDT and heavy dosages of calcium arsenate dusts each gave better bollworm control than benzene hexachloride."[1]

It is apparent that if the insecticide proves to be as effective for controlling cotton pests as early tests indicate, that it will become a number one cotton insecticide. Most authorities to date agree its only weakness is in the control of bollworms. It is the first insecticide to date that will destroy both the boll weevil and cotton aphid at the same time. Used in low dosages no ill effects on cotton plants have been observed thus far.

Other Important Uses

In England trials against flea beetles gave outstanding results. It was found further that the blossom beetle and mustard beetle could be successfully controlled. In our own country the United States Department of Agriculture reported the compound as being effective against melonworm, Southern armyworm, and beet webworm.

Without a doubt the compound will have many important uses in the medical and veterinary fields. It has proven to be highly toxic to lice and fleas. Lice on hogs and cattle, red mites on poultry, and fleas on dogs have all been successfully controlled without injury to the host. The product also showed promise for controlling sheep ticks, sheep blow flies, scab and biting lice.

Early experiments indicate the product to be a successful mosquito larvicide either in a dust or oil solution. Against the larvae of the yellow fever mosquito, the gamma isomer was more toxic than any other insecticide tested. Hexachlorocyclohexane, itself, is approximately of the same order of toxicity as Paris Green and has the advantages of greater safety to game and the ability to be used in oil.

The compound is highly toxic to grasshoppers. In laboratory tests against the African migratory locust conducted in

[1] "Benzene Hexachloride to Control Insects", E. E. Ivy and K. P. Ewing, U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine, Journal of Economic Entomology, February, 1946, Volume 39, Number 1, Page 41.

Dusting cotton. Hexachlorocyclohexane is the only insecticide known which will control most of the common cotton pests at the same time. (Pictures courtesy of THE SOUTHERN PLANTER)

England it was found that hexachlorocyclohexane was 10 times more toxic in baits than sodium arsenic. The British Colonial Office conducted large scale tests in North Africa with highly successful results in 1945.

Mode of Action

As previously pointed out hexachlorocyclohexane has the merit of a three way mode of action.

The examination of the compounds value as a fumigant is relatively simple and tests in which insects were exposed only to its vapor show that it exerts a lethal action at room

temperatures on flies, weevils, and many other pests. In fact, it is very difficult to handle the compound in the laboratory without affecting the insect stock cultures.

Contact action has been demonstrated on houseflies, the German cockroach and other pests. The housefly, although not knocked down with the speed of pyrethrum, is affected with typical convulsions within a few minutes followed eventually by death. Dusted cockroaches show excitement in a few minutes, followed by an onset of convulsions. Death follows in a few hours.

As a stomach poison, the action of hexachlorocyclohexane is very marked. In laboratory tests baits containing one part of the crude compound to 2,000 parts of bran were lethal to grasshoppers feeding on them. The same bait kills crickets under open air conditions on garbage dumps where it is unlikely to exercise any contact or fumigant action.

Comparison with DDT

Since DDT has received such a tremendous amount of publicity in the last few years, it is inevitable that a comparison should be made between this compound and hexachlorocyclohexane. Neither compound is a cure-all for all insect problems. For many insecticidal purposes experimental data show the two compounds to run very parallel for many purposes. On some pests, the control of red spiders for example, neither compound seems to have much value.

Hexachlorocyclohexane is 10 times as toxic to grasshoppers as DDT—and the gamma isomer is 100 times as toxic to this pest. Neither hexachlorocyclohexane nor DDT has any appreciable, fungicidal, or bactericidal properties. Hexachlorocyclohexane is definitely in the developmental stage in this country and snap judgment should not be made with regard to its usefulness until we learn more about its production and toxicity.

Applying DDT to cattle in Kansas in 1945. (Picture courtesy of W. J. Miller, Kansas Livestock Commission)

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The following table illustrates the insects and other pests killed by the gamma isomer of Hexachlorocyclohexane:

Insect Order	*Common Name*
Orthoptera	African migrator locust House Cricket German Cockroach Oriental Cockroach
Anopleura	Human body louse
Hemiptera	Bedbug
Homoptera	Aphids
Lepidoptera	Imported Cabbage Worms Winter moth caterpillars Clothes moth larvae Melon worm Southern army worm Southern beet webworm
Coleoptera	Flea beetle Mustard beetle Blossom beetle Apple blossom weevil Pea weevil Bean weevil Granary weevil Hide beetle
Diptera	Various mosquitoes e. g. Aedes spp. Anopheles spp. Theobaldia spp. Housefly Sheep tick or Ked
Hymenoptera	Wasps Ants
Siphonaptera	Various fleas
Arachnida	Poultry red mite Sheep tick
Crustacea	Wood lice